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Export Entry, Export Exit, and Productivity in German Manufacturing Industries

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Export Entry, Export Exit, and Productivity in German Manufacturing Industries [1]

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This paper contributes to the flourishing literature on exports and productivity by using a unique newly available panel of exporting establishments from the manufacturing sector of Germany from 1995 to 2004 to test three hypotheses derived from a theoretical model by Hopenhayn (Econometrica 1992): (H1) Firms that stop exporting in year t were in t-1 less productive than firms that continue to export in t. (H2) Firms that start to export in year t are less productive than firms that export both in year t-1 and in year t. (H3) Firms from a cohort of export starters that still export in the last year of the panel were more productive in the start year than firms from the same cohort that stopped to export in between. While results for West Germany support all three hypotheses, this is only the case for (H1) and (H2) in East Germany.

Keywords: Export entry, export exit, productivity

JEL classification: F14, L60

[1] All computations for this paper were done inside the Research Data Centre of the Statistical Office of Berlin. Many thanks to Ramona Pohl for running my Stata do-files, and for carefully checking the log-files for violations of privacy.

1. Motivation

Kicked-off by the Brookings paper of Bernard and Jensen (1995) a flourishing literature emerges that uses large-scale longitudinal firm level data to uncover empirical regularities related to differences between exporting and non-exporting firms, and to test empirically hypotheses from theoretical models with heterogeneous firms that export or produce for the national market only developed by Melitz (2003), Bernard et al. (2003), and others. One central topic these papers deal with is the existence, statistical significance, and size of productivity differentials between exporters and non-exporters, and the direction of causality between exports and productivity. A recent review of 45 empirical studies (published between 1995 and 2006) using firm level panel data from 33 countries concludes that exporters are indeed more productive than non-exporters of the same size from the same narrowly defined industry, and that the more productive firms self-select into export markets, while exporting does not necessarily improve productivity (see Wagner 2007a).

While this comprehensive literature deals with productivity differentials between exporters and non-exporters, a related but different set of questions is not dealt with, i.e. whether there are statistically significant productivity differentials between firms that begin to export, or stop exporting, and firms that continue to export. A starting point to organize an empirical analysis of these questions is a model by Hopenhayn (1992) that shows how firms with different levels of productivity make different decisions to enter, exit, or stay in a product market.

Hopenhayn (1992) considers a long-run equilibrium in an industry with many price-taking firms producing a homogeneous good. Output is a function of inputs and a random variable that models a firm specific productivity shock. These shocks are independent between firms, and are the reason for the heterogeneity of firms. There are sunk costs to be paid at entry, and entrants do not know their specific shock in advance. Incumbents can choose between exiting or staying in the market. When firms realized their productivity shock they decide about the profit maximizing volume of production. The model assumes that a higher shock in t+1 has a higher probability the higher the shock is in t. In equilibrium firms will exit if for given prices of output and inputs the productivity shock is smaller than a critical value, and production is no longer profitable.

Following Aw, Chung and Roberts (2000), although not specific to the export market, the Hopenhayn-model can be used to formulate testable hypotheses on the role of productivity levels for entry into, exit from, and survival in the export market that can be viewed as another market besides the national market for the good produced by the firm. Our formulation of testable hypotheses, and the empirical strategy applied to test them, closely follows Farinas und Ruano (2005) in their study of market entry and exit in Spain (that does not consider the export market). This paper contributes to the flourishing literature on exports and productivity by using a unique newly available panel of (nearly) all exporting establishments from the manufacturing sector of Germany from 1995 to 2004 to test the following three hypotheses:

(H1) Firms that exit the export market in year t were in t-1 less productive than firms that continue to produce for the export market in t. Given that firms with low productivity have a higher probability of exit from the export market at a point in time, exiting firms will be concentrated among the least productive units. “Less productive” here means that the productivity distribution of export market exits is stochastically dominated by the productivity distribution of the firms that continue to sell abroad.

(H2) Firms that enter the export market in year t are less productive than firms that exported in year t-1 and continue to do so in year t. This follows from the selection process described above that leads to an improvement of the productivity distribution of incumbents over time because in each period the less productive firms have the highest probability to fall below the critical level and, therefore, to exit. Here, “less productive” means that the productivity distribution of export market entries is stochastically dominated by the productivity distribution of continuing exporters.

(H3) Firms from a cohort of export starters that still export in the last year of the panel were more productive in the start year than firms from the same cohort that stopped to export in between. In the model there is persistence with regard to the productivity shock. Therefore, a firm that starts with a low productivity will have a greater chance to experience a low productivity in the future, and a higher chance of failure. Contrary to that, a firm starting with a high productivity will tend to continue to have a high productivity, and a high chance to survive. “More productive” means that, measured at time t when the firms started to export, the productivity distribution of surviving exporters from a cohort stochastically dominates the productivity distribution of firms from the same cohort that stopped exporting later on.

The rest of the paper is organized as follows: Section 2 describes the data used and discusses measurement issues. Section 3 presents the results of the empirical investigation. Section 4 concludes.

2. Data and measurement issues

This study uses panel data for (nearly) all German manufacturing firms[2] that produced in at least one year between 1995 (when a new industry classification and a new definition of the population of firms covered by the survey was introduced) and 2004 (the last year covered by the data set at hand). While panel data of this type, constructed from the cross section data collected in monthly surveys performed by the Statistical Offices, were available for some German federal states for some periods in the past, only recently the data for all federal states were matched and made available for researchers via the newly created research data centres of the system of official statistics. Based on these data it is possible to produce results using firm level micro data for Germany as a whole for the first time.[3]

To test the hypotheses (H1) – (H3) the productivity of a firm has to be measured, and three groups of firms have to be defined, namely export starters, export stoppers, and continuing exporters.

The productivity of a firm is measured as the amount of annual total sales per employee, divided by the average amount of total sales per employee in the 4-digit industry of the firm, and multiplied by 100 to get a percentage value. Note that all firms that reported to less than twelve monthly surveys in a year (and, therefore, did not exist during the whole year) are excluded from all computations. Furthermore, for some firms extremely high or extremely low sales in some years are reported in the data set, and this leads to extreme values of productivity computed as sales per head. While some of these extreme values might be errors, others are the

[2] By firm a plant, or establishment, is meant. Included are all plants with 20 or more employees, and smaller plants that are part of a multi-plant enterprise with a total of 20 or more employees. To put it differently, small single-establishment enterprises with less than 20 employees are not included in the panel. Given that only a small share of these non-included firms tend to be exporters, the data used in this study cover the vast majority of all exporting firms from the German manufacturing sector.

[3] For details regarding the type of data used here see Wagner (2000). The data set of this study is confidential but not exclusive. Zühlke et al. (2004) describe how to work with confidential data from German official statistics via the research data centres.

consequence of rare events like selling a huge machine that was produced to a large part in year t in the next year, so that no or only low sales are reported for t and high sales for t+1. Given that, on the one hand, extreme values for a small number of observations can have a high impact on empirical results, and that, on the other hand, it is not possible to check all these outliers due to data protection laws, the firms from the top and bottom one percent of the productivity distribution were dropped. Due to missing information on value added and the capital stock used it is not possible to compute value added per employee, or total factor productivity. However, the standardization of the productivity measured at the firm level by the mean value of productivity at the 4-digit level should take care of much of the inter-industry differences in capital intensity and the degree of vertical integration.[4]

A firm is considered to be an *export stopper* in year t if this firm reported a positive amount of exports in year t-1 but not in year t. A firm is considered to be an *export starter* in year t if it did not report a positive amount of exports in year t-1 but in year t. *Continuing exporters* in year t are firms that report a positive amount of exports in year t-1 and t. A firm from a cohort of export starters is said to be a *surviving firm* if it stills exports in 2004 (the last year covered in the data set used), and a *failing firm* if it does not.

Given that there use to be more or less pronounced differences in firm behaviour and performance between West Germany and the former communist East Germany in the years after re-unification in 1990, all computations are done for both parts of Germany separately.

3. Results of the empirical investigation

The hypotheses (H1) – (H3) derived from the model by Hopenhayn (1992) are investigated with firm panel data for manufacturing firms from West and East Germany, respectively, by two methods. In a first step, the mean values of productivity for the two groups of firms (continuing exporters and export stoppers; continuing exporters and export starters; and surviving and failing members of a

[4] Note that Bartelsman and Doms (2000, p. 575) point to the fact that heterogeneity in labor productivity has been found to be accompanied by similar heterogeneity in total factor productivity in the reviewed research where both concepts are measured. Furthermore, Foster, Haltiwanger and Syverson (2005) show that productivity measures that use sales (i.e. quantities multiplied by prices) and measures that use quantities only are highly positively correlated.

cohort of export starters) are compared using a t-test that does not assume equality of variance for the two groups. If one looks at differences in the mean value for both groups only, however, one focuses on just one moment of the productivity distribution. A stricter test that considers all moments is a test for stochastic dominance of the productivity distribution for one group over the productivity distribution for the other group. More formally, let F and G denote the cumulative distribution functions of productivity for the two groups under consideration. Then first order stochastic dominance of F relative to G means that F(z) – G(z) must be less or equal zero for all values of z, with strict inequality for some z. Whether this holds or not is tested non-parametrically by adopting the Kolmogorov-Smirnov test (Conover 1999, p. 456ff.).[5]

- **Continuing exporters vs. export stoppers**

According to (H1) firms that stop exporting in year t were in t-1 less productive than firms that continue to export in t. With the German firm panel data at hand this can be tested for the cohorts of exit from 1996 to 2004. Results are reported in table 1-W and table 1-E for West Germany and East Germany, respectively. The hypothesis is supported by the data. In every year the t-test rejects the null hypothesis of equal means of productivity for stopping and continuing exporters in favour of the alternative hypothesis that export stoppers in t had a smaller value in t-1 than firms that continue to export at an error level of less than 0.001 for West Germany, and less than 0.012 for East Germany. For West Germany in each year between 1996 and 2004 the prob-value for the Kolmogorov-Smirnov test of the null-hypothesis that the distributions of labor productivity for export stoppers and firms that continue to export are identical against the alternative hypothesis that the distribution for continuing exporters first-order stochastically dominates the distribution for export stoppers is 0.000, indicating that the null-hypothesis can be rejected in favour of the alternative hypothesis at any usual error level. Results for East Germany are only slightly different; the null-hypothesis can be rejected at an error level of less than 0.04 in every year.

[Table 1-W and Table 1-E near here]

[5] All computations used Stata 9.2 .

- **Continuing exporters vs. export starters**

The second hypthesis (H2) states that firms that enter the export market in year t are less productive than firms that continue to export in year t. This is tested for cohorts of export starters from the years 1996 to 2004. Results are reported in table 2-W and table 2-E for West Germany and East Germany, respectively. The hypothesis is strongly supported by the data for West Germany according to both the t-test and the Kolmogorov-Smirnov test. Results for East Germany are different. While continuing exporters are on average more productive than export starters in each year under consideration, this difference is statistically different from zero according to the t-test at a usual error level of five percent in six out of nine years considered only. The Kolmogorov-Smirnov test of the null-hypothesis that the distributions of labor productivity for export starters and firms that continue to export are identical against the alternative hypothesis that the distribution for continuing exporters first-order stochastically dominates the distribution for export starters, however, rejects the null-hypothesis in favour of the alternative hypothesis at an error level of five percent in all years but in 1996. Therefore, we find strong evidence for (H2) in East Germany, too.

[Table 2-W and Table 2-E near here]

- **Surviving and failing export starters**

The last hypothesis (H3) to be considered here is that surviving firms from a cohort of export starters were more productive than non-surviving firms from this cohort in the start year. Here, surviving firms are firms that are still active on the export market in 2004, the last year we have information for in the data set used, and the hypothesis can be tested for entry cohorts from 1996 to 2003 (although the time span considered is rather short for the more recent cohorts). The results for West Germany reported in table 3-W support the hypothesis at an error level of five percent or lower in five out of nine years according to the t-test, and in six years according to the Kolmogorov-Smirnov test, while the average labor productivity is lower in failing compared to surviving firms in every year. The picture for East Germany is different. While the average value of labor productivity is larger in surviving than in failing firms (with the exceprion of one year, namely 2000), this difference is never statistically

significantly different from zero for the first five cohorts considered here according to both tests applied. While the big picture, therefore, tends to be in line with (H3) for West Germany, this is not the case for East Germany. At least in part this might be due to the small number of cases in both groups (failing and surviving exporters), while subsidies paid to East German firms might play a role, too (although we cannot test this due to the lack of information in the data).

[Table 2-W and Table 2-E near here]

4. Concluding remarks

Using a unique newly available panel of exporting establishments from the manufacturing sector of Germany from 1995 to 2004 this paper tests three hypotheses derived from a theoretical model by Hopenhayn (Econometrica 1992): (H1) Firms that stop exporting in year t were in t-1 less productive than firms that continue to export in t. (H2) Firms that start to export in year t are less productive than firms that export both in year t-1 and in year t. (H3) Firms from a cohort of export starters that still export in the last year of the panel were more productive in the start year than firms from the same cohort that stopped to export in between. While results for West Germany support all three hypotheses, this is only the case for (H1) and (H2) in East Germany.

These findings regarding the decisive role of productivity for export market exit and entry are in line with the results from studies looking at the role of productivity for market entry and exit in general by Farinas and Ruano (2005) for Spain, replicated by Wagner (2007b) for Germany, and with findings from the international literature on productivity and selection (cf. Bartelsman and Doms 2000, p. 581). To foster productivity growth, and growth in general, economic policy should not interfere with these selection processes of the fittest.

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Table 1-W: Productivity differences between continuing exporters and export stoppers: West Germany*

Cohort	[1] Export stoppers [No. of cases]	[2] Continuing exporters [No. of cases]	[3] t-test for differences in means [1] < [2] (prob-value)	[4] Kolmogorov-Smirnov-test for stochastic dominance [1] < [2] (prob-value)
1996	92.60	105.89	0.000	0.000
	[730]	[21736]		
1997	93.10	105.58	0.000	0.000
	[627]	[21603]		
1998	92.31	106.55	0.000	0.000
	[675]	[21787]		
1999	92.65	106.56	0.000	0.000
	[673]	[21691]		
2000	93.11	106.07	0.000	0.000
	[667]	[21808]		
2001	89.21	106.39	0.000	0.000
	[608]	[22030]		
2002	91.15	106.51	0.000	0.000
	[650]	[22061]		
2003	90.23	106.80	0.000	0.000
	[558]	[22343]		
2004	86.47	106.51	0.000	0.000
	[618]	[22595]		

* For a definition of export stoppers and continuing exporters see text. Columns [1] and [2] report mean values of percentage deviations of labor productivity from the respective mean values of the industries (4-digit classification]; see text. Column [3] reports the result of a test of the null hypothesis of equal means in column [1] and column [2] against the alternative hypothesis of a smaller mean value in column [1]; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent (or less). Column [4] reports the result of a test of the null hypothesis of identical distributions of labor productivity in both groups of firms against the alternative hypothesis that the distribution for exiting firms is first-order stochastically dominated by the distribution for continuing firms; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected at an error level of 5 percent (or smaller).

Table 1-E: Productivity differences between continuing exporters and export stoppers: East Germany*

Cohort	[1] Export stoppers [No. of cases]	[2] Continuing exporters [No. of cases]	[3] t-test for differences in means [1] < [2] (prob-value)	[4] Kolmogorov-Smirnov-test for stochastic dominance [1] < [2] (prob-value)
1996	88.26	108.25	0.000	0.000
	[222]	[2202]		
1997	99.03	110.23	0.012	0.039
	[189]	[2278]		
1998	96.32	112.36	0.002	0.004
	[165]	[2418]		
1999	97.80	113.86	0.000	0.001
	[191]	[2519]		
2000	92.66	113.29	0.000	0.000
	[179]	[2664]		
2001	98.84	113.90	0.000	0.009
	[187]	[2856]		
2002	91.39	113.54	0.000	0.000
	[208]	[2991]		
2003	94.75	114.29	0.000	0.001
	[169]	[3194]		
2004	92.39	112.89	0.000	0.000
	[205]	[3430]		

* For a definition of export stoppers and continuing exporters see text. Columns [1] and [2] report mean values of percentage deviations of labor productivity from the respective mean values of the industries (4-digit classification]; see text. Column [3] reports the result of a test of the null hypothesis of equal means in column [1] and column [2] against the alternative hypothesis of a smaller mean value in column [1]; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent (or less). Column [4] reports the result of a test of the null hypothesis of identical distributions of labor productivity in both groups of firms against the alternative hypothesis that the distribution for exiting firms is first-order stochastically dominated by the distribution for continuing firms; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected at an error level of 5 percent (or smaller).

Table 2-W: Productivity differences between continuing exporters and export starters: West Germany*

Cohort	[1] Export starters [No. of cases]	[2] Continuing exporters [No. of cases]	[3] t-test for differences in means [1] < [2] (prob-value)	[4] Kolmogorov-Smirnov-test for stochastic dominance [1] < [2] (prob-value)
1996	89.56	105.89	0.000	0.000
	[745]	[21736]		
1997	93.55	105.58	0.000	0.000
	[722]	[21603]		
1998	91.63	106.55	0.000	0.000
	[704]	[21787]		
1999	90.23	106.56	0.000	0.000
	[731]	[21691]		
2000	89.02	106.07	0.000	0.000
	[695]	[21808]		
2001	94.22	106.39	0.000	0.000
	[711]	[22030]		
2002	91.36	106.51	0.000	0.000
	[651]	[22061]		
2003	99.84	106.80	0.001	0.000
	[1161]	[22343]		
2004	91.61	106.51	0.000	0.000
	[561]	[22595]		

* For a definition of export starters and continuing exporters see text. Columns [1] and [2] report mean values of percentage deviations of labor productivity from the respective mean values of the industries (4-digit classification]; see text. Column [3] reports the result of a test of the null hypothesis of equal means in column [1] and column [2] against the alternative hypothesis of a smaller mean value in column [1]; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent (or less). Column [4] reports the result of a test of the null hypothesis of identical distributions of labor productivity in both groups of firms against the alternative hypothesis that the distribution for entering firms is first-order stochastically dominated by the distribution for continuing firms; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected at an error level of 5 percent (or smaller).

Table 2-E: Productivity differences between continuing exporters and export starters: East Germany*

Cohort	[1] Export starters [No. of cases]	[2] Continuing exporters [No. of cases]	[3] t-test for differences in means [1] < [2] (prob-value)	[4] Kolmogorov-Smirnov-test for stochastic dominance [1] < [2] (prob-value)
1996	104.58 [232]	108.25 [2202]	0.232	0.102
1997	106.54 [234]	110.23 [2278]	0.249	0.044
1998	96.76 [222]	112.36 [2418]	0.000	0.016
1999	93.19 [216]	113.86 [2519]	0.000	0.000
2000	103.46 [218]	113.29 [2664]	0.031	0.001
2001	92.15 [240]	113.90 [2856]	0.000	0.000
2002	108.77 [229]	113.54 [2991]	0.230	0.000
2003	98.00 [353]	114.29 [3194]	0.000	0.000
2004	97.31 [226]	112.89 [3430]	0.000	0.001

* For a definition of export starters and continuing exporters see text. Columns [1] and [2] report mean values of percentage deviations of labor productivity from the respective mean values of the industries (4-digit classification]; see text. Column [3] reports the result of a test of the null hypothesis of equal means in column [1] and column [2] against the alternative hypothesis of a smaller mean value in column [1]; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent (or less). Column [4] reports the result of a test of the null hypothesis of identical distributions of labor productivity in both groups of firms against the alternative hypothesis that the distribution for entering firms is first-order stochastically dominated by the distribution for continuing firms; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected at an error level of 5 percent (or smaller).

Table 3-W: Productivity differences between surviving and failing members of various export entry cohorts: West Germany*

Cohort	[1] Failing firms [No. of cases]	[2] Surviving firms [No. of cases]	[3] t-test for differences in means [1] < [2] (prob-value)	[4] Kolmogorov-Smirnov-test for stochastic dominance [1] < [2] (prob-value)
1996	86.71 [450]	93.92 [295]	0.024	0.016
1997	87.60 [386]	100.38 [336]	0.001	0.001
1998	88.53 [378]	95.22 [326]	0.067	0.000
1999	86.92 [389]	93.99 [342]	0.037	0.102
2000	86.68 [344]	91.32 [351]	0.107	0.011
2001	84.98 [328]	102.12 [383]	0.000	0.000
2002	88.37 [265]	93.42 [386]	0.111	0.239
2003	86.41 [334]	105.27 [827]	0.000	0.000

* For a definition of failing and surviving firms see text. Columns [1] and [2] report mean values of percentage deviations of labor productivity from the respective mean values of the industries (4-digit classification]; see text. Column [3] reports the result of a test of the null hypothesis of equal means in column [1] and column [2] against the alternative hypothesis of a smaller mean value in column [1]; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent (or less). Column [4] reports the result of a test of the null hypothesis of identical distributions of labor productivity in both groups of firms against the alternative hypothesis that the distribution for failing firms is first-order stochastically dominated by the distribution for surviving firms; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected at an error level of 5 percent (or smaller).

Table 3-E: Productivity differences between surviving and failing members of various export entry cohorts: East Germany*

Cohort	[1] Failing firms [No. of cases]	[2] Surviving firms [No. of cases]	[3] t-test for differences in means [1] < [2] (prob-value)	[4] Kolmogorov-Smirnov-test for stochastic dominance [1] < [2] (prob-value)
1996	103.47 [135]	106.14 [97]	0.390	0.300
1997	103.03 [122]	110.37 [112]	0.242	0.332
1998	95.91 [104]	97.51 [118]	0.340	0.517
1999	89.50 [110]	97.00 [106]	0.144	0.117
2000	106.38 [89]	101.45 [129]	0.688	0.945
2001	84.42 [110]	98.69 [130]	0.018	0.064
2002	98.04 [89]	115.60 [140]	0.063	0.225
2003	85.75 [113]	103.77 [240]	0.003	0.002

* For a definition of failing and surviving firms see text. Columns [1] and [2] report mean values of percentage deviations of labor productivity from the respective mean values of the industries (4-digit classification]; see text. Column [3] reports the result of a test of the null hypothesis of equal means in column [1] and column [2] against the alternative hypothesis of a smaller mean value in column [1]; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent (or less). Column [4] reports the result of a test of the null hypothesis of identical distributions of labor productivity in both groups of firms against the alternative hypothesis that the distribution for failing firms is first-order stochastically dominated by the distribution for surviving firms; a prob-value of 0.05 (or smaller) indicates that the null hypothesis can be rejected at an error level of 5 percent (or smaller).

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